WATER RESOURCES REVIEW for

DECEMBER

1973

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

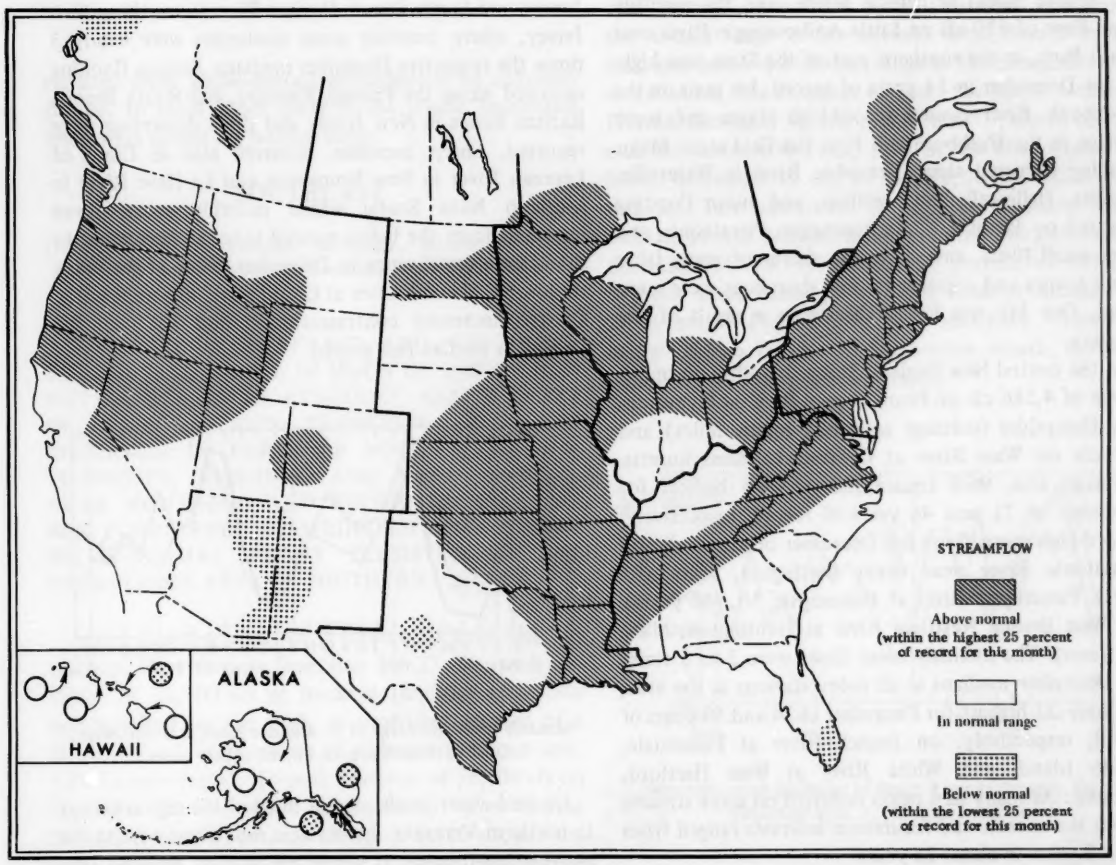
CANADA
DEPARTMENT OF THE ENVIRONMENT
WATER RESOURCES BRANCH

STREAMFLOW AND GROUND-WATER CONDITIONS

Streamflow generally increased in the Atlantic Provinces of Canada, in much of eastern United States and parts of the West, and decreased in Alaska and Hawaii. Flow conditions were variable in other parts of southern Canada and the United States.

Above-normal flows persisted in large areas in the eastern, central, and northwestern parts of the United States, and flows remained below normal in small areas in British Columbia, Alaska, Arizona, New Mexico, and Florida.

Moderate to severe flooding occurred in parts of New England, New Jersey, Virginia, West Virginia, North Carolina, Tennessee, Louisiana, and Missouri.



CONTENTS OF THIS ISSUE: Northeast, Southeast, Western Great Lakes region, Midcontinent, West; Usable contents of selected reservoirs near end of December 1973; Flow of large rivers during December 1973; Alaska, Hawaii; Generalization of stream-temperature data in Washington.

NORTHEAST

[Atlantic Provinces and Quebec; Delaware, Maryland, New York, New Jersey, Pennsylvania, and the New England States]

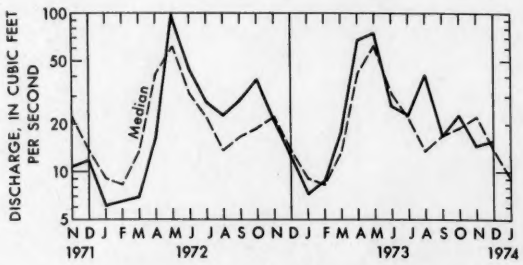
STREAMFLOW GENERALLY INCREASED SEASONALLY AND WAS ABOVE THE NORMAL RANGE IN MUCH OF THE REGION. MODERATE TO SEVERE FLOODING OCCURRED IN PARTS OF THE NEW ENGLAND STATES AND NEW JERSEY. FLOOD DAMAGE IN MAINE WAS ESTIMATED TO BE ABOUT FIVE MILLION DOLLARS.

Record-breaking floods occurred on some streams in central and southern Maine where three major flood peaks were recorded during the 8-day period, December 14–21. As much as 10 inches of rain fell at some points in the area during that period. The monthly mean discharge of 3,612 cfs and the daily mean of 14,700 cfs on the 22d were highest for December in 71 years of record on Piscataquis River near Dover-Foxcroft (drainage area, 297 square miles) in central Maine, and the monthly mean flow of 610 cfs on Little Androscoggin River near South Paris, in the southern part of the State, was highest for December in 54 years of record. Ice jams on the Aroostook River caused record-high stages and some damage in the Washburn and Fort Fairfield areas. Major flooding occurred along Kennebec River in Waterville, Augusta, Hallowell, and Gardiner, and minor flooding occurred on Penobscot, Androscoggin, Piscataquis, and other small rivers, and along the shores of many lakes where homes and cottages on low shorelines were inundated. One life was lost in Maine as a result of the flooding.

In the central New England States, monthly mean discharge of 4,586 cfs on Pemigewasset River at Plymouth, New Hampshire (drainage area, 622 square miles), and 437 cfs on Ware River at Coldbrook, Massachusetts, (drainage area, 96.8 square miles), were highest for December in 71 and 46 years of record, respectively. Record-high mean flows for December occurred also on Housatonic River near Great Barrington, Mass. (61 years), Passumpsic River at Passumpsic, Vt. (46 years), and West Branch Westfield River at Huntington, Mass. (39 years). The monthly mean flows were 3 to 5 times the December medians at all index stations in the area, and were 2d highest for December in 34 and 59 years of record, respectively, on Branch River at Forestdale, Rhode Island, and White River at West Hartford, Vermont. As many as 6 peaks occurred on some streams during the month and recurrence intervals ranged from about 2 years to about 25 years.

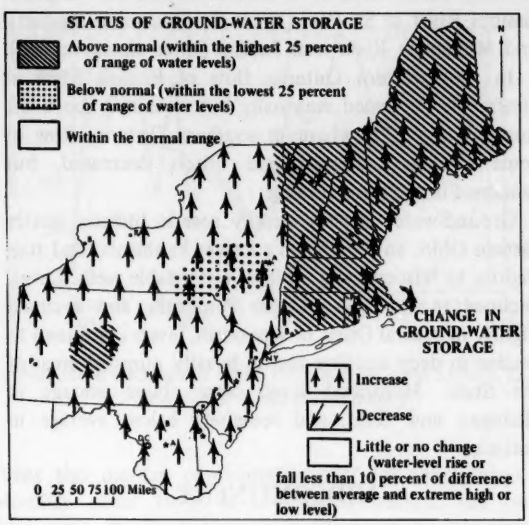
Moderate flooding occurred in parts of Connecticut and monthly mean flows at the index stations generally were about 3 to 4 times December medians. The monthly mean discharges on Burlington Brook near Burlington and Pomeraug River at Southbury were highest for December since records began at those index stations in 1931 and 1932, respectively. On Salmon River near East Hampton (drainage area, 102 square miles) the monthly mean flow of 495 cfs was 2d highest, and the daily mean of 3,140 cfs on the 21st was the highest for the month in 46 years of record. Similarly, on Mt. Hope River near Warrenville (drainage area, 28.6 square miles) the monthly mean flow of 152 cfs was 2d highest, and the daily mean of 911 cfs on the 21st was the highest for the month since records began in 1940.

Monthly mean flow in the Susquehanna River basin increased sharply and was about double the December median at the index stations at Conklin, in south-central New York, and at Harrisburg, in southeastern Pennsylvania. Similar sharp increases occurred on the Potomac River at Washington, D.C., Seneca Creek in western Maryland, Delaware River at Trenton, New Jersey, and South Branch Raritan River in northern New Jersey, where monthly mean discharges were nearly 3 times the respective December medians. Serious flooding occurred along the Passaic, Ramapo, and South Branch Raritan Rivers in New Jersey and three drownings were reported. Sharp increases occurred also in flows of Lepreau River in New Brunswick and La Have River in southern Nova Scotia where monthly mean flows increased from the below-normal range in November to the above-normal range in December. Flow at the index station, St. Maurice River at Grand Mere, in southeastern Quebec, increased contraseasonally and was near the December median (see graph).



Monthly mean discharge of St. Maurice River at Grand Mere, Quebec (Drainage area, 16,200 square miles.)

Ground-water levels rose in most of the region except in northern Vermont. Levels near monthend were in the above-normal range in nearly all of New England (see map), including highest end-of-December levels recorded in the past 20 or 25 years in some wells as a result of


STATUS OF GROUND-WATER STORAGE
Above normal (within the highest 25 percent of range of water levels)
Below normal (within the lowest 25 percent of range of water levels)
Within the normal range
N
CHANGE IN GROUND-WATER STORAGE
Increase
Decrease
Little or no change (water-level rise or fall less than 10 percent of difference between average and extreme high or low level)
0 25 50 75 100 Miles

Map shows ground-water storage near end of December and change in ground-water storage from end of November to end of December.

recharge from above-normal precipitation on unfrozen ground. In most other parts of the region, monthend levels were within the normal range.

SOUTHEAST

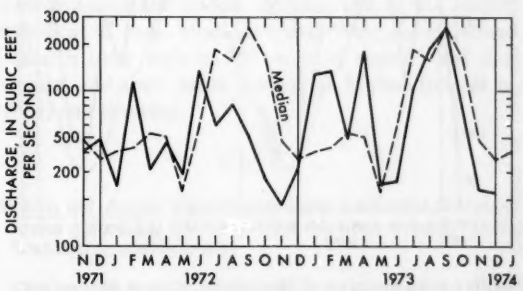
[Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia]

STREAMFLOW INCREASED AND WAS ABOVE THE NORMAL RANGE IN MUCH OF THE REGION BUT DECREASED IN KENTUCKY AND IN PARTS OF FLORIDA AND TENNESSEE. FLOODING OCCURRED IN PARTS OF NORTH CAROLINA, TENNESSEE, VIRGINIA, AND WEST VIRGINIA NEAR MONTHEND, AND RECORD-HIGH DECEMBER FLOWS WERE RECORDED IN SOME BASINS. BELOW-NORMAL FLOWS PERSISTED IN THE EVERGLADES AREA OF SOUTHERN FLORIDA.

Severe flooding occurred in Greenbrier River basin in southern West Virginia December 26–27. The peak discharge of 33,700 cfs at Buckeye (drainage area, 540 square miles) on the 26th, is equivalent to that of a 25-year flood. Downstream at Alderson (drainage area, 1,357 square miles), the peak discharge of 56,100 cfs on December 27 was about the equivalent of a 15-year flood. The monthly mean discharge of 6,415 cfs, and the daily mean of 49,600 cfs on the 27th, were highest for December at Alderson in record that began in 1895. Major flooding occurred also in Jackson River basin in central Virginia, in the Covington and Clifton Forge areas, as a result of runoff caused by intense rains falling on a considerable accumulation of snow. The peak stage of 14.45 feet on December 26, on Jackson River at Falling Springs, was the second highest since records began there in 1925. The maximum stage of record at that site, 14.74 feet, occurred March 17, 1936. Moderate flooding was reported in many parts of the State near monthend. Locally intense rains in east-central Tennessee on December 25–26, caused some flooding along small streams but damage was minimal. Minor flooding occurred also December 25–26 in the upper French Broad River basin in western North Carolina.

Streamflow generally was above the normal range in a broad band extending from central Mississippi, where monthly means were 4 to 5 times December medians, through northern Alabama, northern Georgia, and western North Carolina, into the Virginias, where December mean flows were 2 to 4 times median flows for the month.

In Florida, mean flows during December were above the normal range in the extreme west, normal in the east, and below the normal range in the Everglades area in the south. The discharge of Silver Springs, in northern Florida, decreased 40 cfs, to 720 cfs; 87 percent of normal. In southern Florida, flow in the Miami canal at Miami decreased 42 cfs, to 159 cfs; 54 percent of normal, and flow southward through the Tamiami canal outlets, 40-mile bend to Monroe, in the Everglades area, decreased 26 cfs, to 20 cfs; 32 percent of normal. Monthly mean discharge of Peace River at Arcadia, in south-central Florida decreased seasonally, remained below median for the 3d consecutive month, but was within the normal range (see graph).



Monthly mean discharge of Peace River at Arcadia, Fla. (Drainage area, 1,370 square miles.)

Ground-water levels generally rose in Virginia, West Virginia, the mountain and western Piedmont areas of

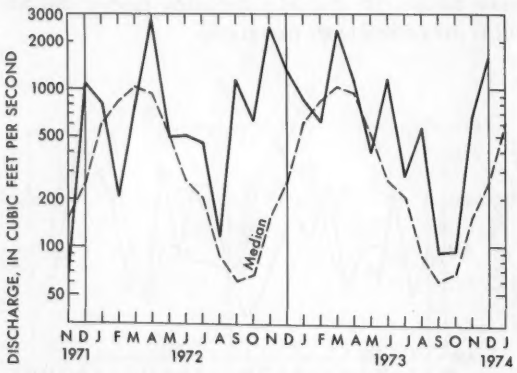
North Carolina, and in northwestern Mississippi in the shallow Mississippi River alluvium; and began to rise also in the Piedmont of Georgia following declines early in the month. Levels fell in Florida. In Kentucky, levels declined in most wells, following the near-record highs (for November) of the previous month. In North Carolina, levels declined in the Coastal Plain and in the eastern Piedmont. Monthend levels were above average in the western two-thirds of West Virginia (below average in the eastern third), and in Kentucky, and at least slightly above average in North Carolina. Levels were near or below average in most of Florida.

WESTERN GREAT LAKES REGION

[Ontario; Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin]

STREAMFLOW GENERALLY INCREASED IN EASTERN AND SOUTHERN PARTS OF THE REGION BUT DECREASED SEASONALLY IN MINNESOTA, ONTARIO, AND WISCONSIN. ABOVE-NORMAL FLOWS CHARACTERIZED A BROAD BAND ACROSS THE REGION, FROM OHIO IN THE SOUTHEAST TO MINNESOTA AND SOUTHWESTERN ONTARIO IN THE NORTHWEST. MINOR FLOODING OCCURRED IN THE WHITE AND WABASH RIVER BASINS IN SOUTHERN INDIANA.

Above-normal flows persisted in the Pecatonica River basin in southern Wisconsin and northern Illinois for the 17th consecutive month. Cumulative runoff at the index station at Freeport, Illinois was more than twice the median during that period. Monthly mean flows also remained above the normal range in northeastern Wisconsin for the 12th consecutive month and in central Ohio for the 7th consecutive month. In north-central Indiana, monthly mean discharge of Mississinewa River at Marion increased seasonally, was 6 times the December median, and above the normal range for the 2d consecutive month (see graph).



Monthly mean discharge of Mississinewa River at Marion, Ind. (Drainage area, 682 square miles.)

In Minnesota, high carryover flows from October, coupled with above-normal temperatures Statewide, and near-or-above-normal precipitation in the southern two-thirds of the State, contributed to the above-normal monthly mean flows at all index stations, including Mississippi River at St. Paul (twice the December median), and Minnesota River near Jordan (three times median).

In southwestern Ontario, flow of English River at Umfreville decreased seasonally but remained above the normal range. Elsewhere in southern Ontario, flow of some streams increased and others decreased, but remained in the normal range.

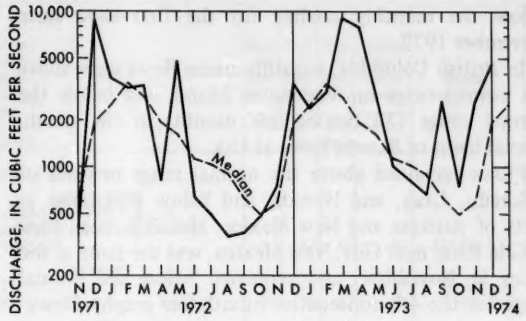
Ground-water levels generally rose in Indiana, northeastern Ohio, and Michigan's Lower Peninsula; and rose slightly in Wisconsin in shallow water-table wells. Levels declined in Michigan's Upper Peninsula, and declined slightly in central Ohio. In Wisconsin, levels continued to decline in deep aquifers and in heavily pumped areas of the State. Monthend levels were above average in Michigan and Ohio, and remained below average in Indiana.

MIDCONTINENT

[Manitoba and Saskatchewan; Arkansas, Iowa, Kansas, Louisiana, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota, and Texas]

STREAMFLOW INCREASED IN SOME BASINS AND DECREASED IN OTHERS AND GENERALLY WAS ABOVE THE NORMAL RANGE EXCEPT IN SOUTHERN SASKATCHEWAN AND MANITOBA, AND IN PARTS OF NORTH DAKOTA, SOUTH DAKOTA, NEBRASKA, AND TEXAS, WHERE NORMAL, OR BELOW-NORMAL DECEMBER FLOWS OCCURRED. MINOR TO MODERATE FLOODING WAS REPORTED IN PARTS OF MISSOURI AND LOUISIANA AND MONTHLY MEAN FLOWS WERE HIGHEST, OR NEAR-HIGHEST, FOR THE MONTH IN PARTS OF ARKANSAS AND IOWA.

Runoff from intense rains, of 3 to 5 inches, December 3 and 4, caused flooding in northwestern Louisiana. Recurrence intervals of the peak discharges ranged between 2 and 5 years. Near monthend, runoff from rains of 5 to 8 inches in the Bogalusa area of southeastern Louisiana resulted in moderate flooding along Pearl River and a peak discharge at Bogalusa equal to that of a 17-year flood. Monthly mean flow of Amite River near Denham Springs, also in the southeastern part of the State, increased sharply, was more than twice the December median, and above the normal range for the 4th consecutive month (see graph). In Missouri, bankfull stages occurred on streams in all parts of the State and minor flooding was reported in the Platte, Blue, Grand, and Osage River basins. Cumulative runoff of Grand River near Gallatin, in northwestern Missouri, during the 3-month period October through December, was 27



Monthly mean discharge of Amite River near Denham Springs, La. (Drainage area, 1,280 square miles.)

times the median cumulative runoff for that period. Monthly mean flows at that index station, and on Gasconade River at Jerome, in southeastern Missouri, have been in the above-normal range for 3 consecutive months.

In Iowa, high carryover flows from November, augmented by several periods of moderate storm runoff during December, resulted in record- or near record-high December mean flows throughout the State. At the index station on Cedar River at Cedar Rapids, in the east, December flow was highest for the month since 1931, and the 4th highest December monthly mean since records began in 1902. In the north-central and southwestern parts of Iowa, flows of Winnebago River at Mason City and Nishnabotna River near Hamburg, were highest for the month in records that began in 1933 and 1922, respectively. An ice storm over much of the State December 4, caused extensive damage to electric power lines. High carryover flows from November also contributed to the above-normal December monthly mean discharges in the Neches and Guadalupe River basins of eastern and southern Texas. Flows have been above the normal range at index stations in those basins during the past 9 and 6 months, respectively. In west-central Texas, no flow has occurred at the index station on North Concho River near Carlsbad since July 20. In Arkansas, frequent rains during December and high carryover flows from November resulted in above-normal monthly mean discharges at the two index stations. On Saline River near Rye (drainage area, 2,062 square miles), in the southeast, the December mean of 12,775 cfs, and the daily mean of 30,400 cfs on the 3d, were highest for December in record that began in October 1937. On Buffalo River near St. Joe, in the north, monthly mean discharge was 5 times the December median, above the normal range for the 3d consecutive month, and cumulative runoff, October through December, was more than 7 times normal runoff during that period. In Kansas, seasonally normal precipitation, coupled with high carryover flows from November, resulted in record-high, and above-normal, December mean discharges at the index stations on Little Blue River near Barnes and Saline River near Russell. The cumulative runoff during the 3-month period, October through December, was 16 and 11 times normal runoff for the period at those stations, respectively. In Oklahoma, streamflow was at or above normal in all parts of the State and flow at the index station, Washita River near Durwood, was above the normal range for the 3d consecutive month, and 5 times the December median. In North Dakota, flow of Red River of the North at Grand Forks decreased seasonally but remained above the normal range for the 4th consecutive month, largely as a result of high tributary inflow from Minnesota. In southern North Dakota, flow of Cannonball River near Breien increased contraseasonally, was 3 times the December median, and in the above-normal range.

In Manitoba, flow at the index station, Waterhen River below Waterhen Lake, decreased seasonally and remained in the normal range. The level of Lake Winnipeg at Gimli averaged 714.14 feet above mean sea level, 1.11 feet above the long-term mean for December and 0.08 foot higher than last month.

Ground-water levels rose or remained about the same in the northern and central parts of the region. Levels rose in most of Nebraska. Monthend levels were above average in Nebraska and Iowa, and near average in North Dakota. In the Grand Prairie area of east-central Arkansas, levels were unchanged in the shallow aquifer (Quaternary deposits) and continued to rise seasonally in the deep aquifer (Sparta Sand); in the industrial aquifer in the central and southern part of the State, levels rose at Pine Bluff (but were at a new low for December) and El Dorado. In the Pleistocene terrace deposits of northwestern Louisiana, levels declined slightly and were slightly below average; levels continued to rise in the Chicot aquifer in the southwestern rice-growing area but were lowest of record for December. In Texas, levels rose in the Edwards Limestone at Austin and in the Evangeline aquifer at Houston; and declined in the Edwards Limestone at San Antonio and in the bolson deposits at El Paso. Monthend levels were above average at Austin (new high in 30 years of record) and San Antonio, and were below average at El Paso (lowest of record) and Houston.

WEST

[Alberta and British Columbia; Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming]

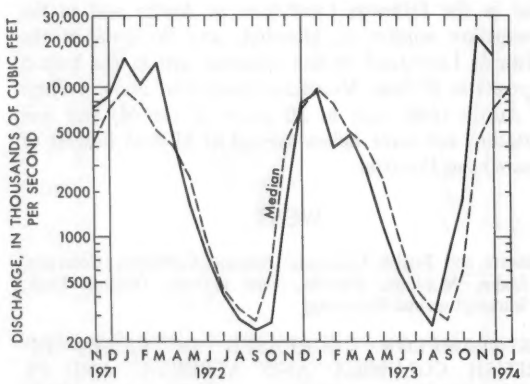
STREAMFLOW INCREASED IN PARTS OF BRITISH COLUMBIA AND ALBERTA, AND IN WASHINGTON, OREGON, NEVADA, AND ARIZONA, AND GENERALLY DECREASED ELSEWHERE IN THE REGION. ABOVE-NORMAL FLOWS PERSISTED IN A LARGE AREA CENTERED ON SOUTHEASTERN OREGON. FLOWS ALSO WERE ABOVE NORMAL IN SMALLER AREAS IN ALBERTA, BRITISH COLUMBIA, UTAH, AND

COLORADO. BELOW-NORMAL MONTHLY FLOWS PERSISTED IN NORTHERN BRITISH COLUMBIA, EASTERN ARIZONA, AND WESTERN NEW MEXICO.

For the 4th consecutive month, streamflow increased in most parts of Washington and Oregon. Monthly mean flow of Columbia River at The Dalles, Oregon, increased seasonally in December and was above the normal range for the 3d consecutive month. In northeastern Oregon, mean flow of John Day River at Service Creek increased, from the record-high monthly mean of November, and was more than 6 times the December median. Flow at that index station was below the normal range during the last 7 months of the 1973 water year. Cumulative runoff at that site during the first 3 months of the 1974 water year has been about 5 times median for the period. In west-central Washington, where cumulative flow of Spokane River at Spokane was only 45 percent of median during the 8-month period, February through September, 1973, monthly mean flow during December increased, was nearly 3 times the monthly median, and was in the above-normal range.

In Idaho, high carryover flows from November, augmented by above-normal temperatures and precipitation throughout the month, contributed to the above-normal streamflow in all parts of the State. Flow of Snake River, in southern Idaho and western Wyoming, was above the normal range.

In California, streamflow ranged from above-normal flow in the north-coastal area to less than median flow in the southern part of the State. Flow of Smith River near Crescent City (north-coastal area) decreased slightly, from the record-high flow of November, and remained in the above-normal range for the 4th consecutive month (see graph). Snow pack at monthend, at Donner Pass in

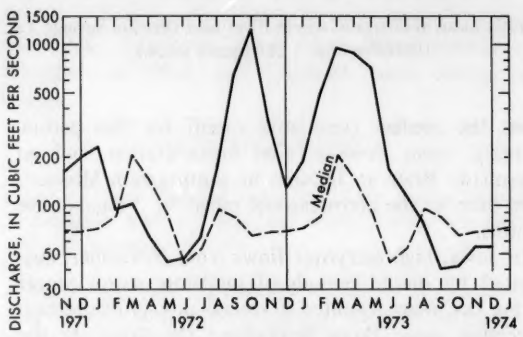


Monthly mean discharge of Smith River near Crescent City, Calif.
(Drainage area, 609 square miles.)

the Sierra Nevada, was 72 inches; more than twice the normal for this time of year. In southern California, monthly mean flow of Arroyo Seco near Pasadena was below the monthly median for the first time since November 1972.

In British Columbia, monthly mean flows were above the normal range on Vancouver Island, and below the normal range (3d consecutive month) in the north-coastal basin of Skeena River at Usk.

Flows remained above the normal range in parts of Colorado, Utah, and Nevada, and below that range in parts of Arizona and New Mexico. Monthly mean flow of Gila River near Gila, New Mexico, was the same as the mean in November, and remained below the normal range for the 4th consecutive month (see graph). Down-



Monthly mean discharge of Gila River near Gila, N. Mex.
(Drainage area, 1,864 square miles.)

stream, flow of Gila River at head of Safford Valley, near Solomon, Arizona, increased seasonally, but remained in the below-normal range for the 5th consecutive month. In northern Utah, monthly mean discharge of Cottonwood Creek near Salt Lake City remained in the above-normal range for the 5th consecutive month. Also, in the north, the level of Great Salt Lake rose 0.25 foot (to 4,199.65 feet above mean sea level), 0.90 foot higher than a year ago, and 1.75 feet higher than the average monthly level for December.

Reservoir storage at monthend generally was near or above average in the major reservoirs of the region, but was below average in some reservoirs in Colorado and Montana. Contents of the Colorado River Storage Project decreased 17,600 acre-feet during the month.

Ground-water levels generally rose in Washington, Nevada (except in the heavily pumped Truckee Meadows and Las Vegas Valley areas), and southern New Mexico. Levels declined in Montana, in Idaho's Boise Valley (sand and gravel aquifer), and in Utah in the Logan (northern part of State) and Blanding (southeastern) areas. Monthend levels were above average in Montana, Washington, in Idaho in eastern and western parts of the Snake River Plain and in the Boise Valley, and in the Blanding area of southeastern Utah. Levels continued near average in observation wells in southern California; and were below average in southern New Mexico, the Logan area of northern Utah, and in the Rupert-Minidoka area in the central part of Idaho's Snake River Plain.

Provisional data; subject to revision

USABLE CONTENTS OF SELECTED RESERVOIRS NEAR END OF DECEMBER 1973

[Contents are expressed in percent of reservoir capacity. The usable storage capacity of each reservoir is shown in the column headed "Normal maximum."]

Reservoir Principal uses: F–Flood control I–Irrigation M–Municipal P–Power R–Recreation W–Industrial	End of Nov. 1973	End of Dec. 1973	End of Dec. 1972	Average for end of Dec.	Normal maximum
	Percent of normal maximum				
NORTHEAST REGION					
NOVA SCOTIA					
Rossignol, Mulgrave, Falls Lake, St. Margaret's Bay, Black, and Ponhook Reservoirs (P)	41	52	68	42	223,400 (a)
QUEBEC					
Gouin (P)	93	91	64	68	10,865 ac-ft
Allard (P)	78	92	95	53	438 ac-ft
MAINE					
Seven reservoir systems (MP)	68	85	63	54	178,489 mcf
NEW HAMPSHIRE					
Lake Winnipesaukee (PR)	62	103	78	58	7,200 mcf
Lake Francis (FPR)	64	82	75	68	4,326 mcf
First Connecticut Lake (P)	69	90	71	62	3,330 mcf
VERMONT					
Somerset (P)	65	85	75	65	2,500 mcf
Harriman (P)	59	89	63	59	5,060 mcf
MASSACHUSETTS					
Cobble Mountain and Borden Brook (MP)	63	83	78	73	3,394 mcf
NEW YORK					
Great Sacandaga Lake (FPR)	45	63	67	52	34,270 mcf
Indian Lake (FMP)	72	86	69	59	4,500 mcf
New York City reservoir system (MW)	64	82	96	.....	547,500 mg
NEW JERSEY					
Wanaque (M)	53	88	101	71	27,730 mg
PENNSYLVANIA					
Wallenpaupack (P)	49	91	75	53	6,875 mcf
Pymatuning (FMR)	77	90	88	79	8,191 mcf
MARYLAND					
Baltimore municipal system (M)	91	94	101	82	85,340 mg
SOUTHEAST REGION					
NORTH CAROLINA					
Bridgewater (Lake James) (P)	72	89	87	74	12,580 mcf
High Rock Lake (P)	39	89	94	63	10,230 mcf
Narrows (Badin Lake) (P)	93	94	100	94	5,616 mcf
SOUTH CAROLINA					
Lake Murray (P)	83	85	81	56	70,300 mcf
Lakes Marion and Moultrie (P)	81	64	89	57	81,100 mcf
SOUTH CAROLINA--GEORGIA					
Clark Hill (FP)	65	61	66	48	75,360 mcf
GEORGIA					
Burton (PR)	61	72	80	49	104,000 ac-ft
Lake Sidney Lanier (FMPR)	53	61	51	52	1,686,000 ac-ft
Sinclair (MPR)	83	73	97	71	214,000 ac-ft
ALABAMA					
Lake Martin (P)	73	117	77	56	1,373,000 ac-ft
TENNESSEE VALLEY					
Clinch Projects: Norris and Melton Hill Lakes (FPR)	61	61	44	25	1,156,000 cfsd
Holston Projects: South Holston, Watauga, Boone, Fort Patrick Henry, and Cherokee Lakes (FPR)	57	51	54	27	1,452,000 cfsd
Douglas Lake (FPR)	26	24	19	8	703,100 cfsd
Hiwassee Projects: Chatuge, Nottely, Hiwassee, Apalachia, Blue Ridge, Ocoee 3, and Parksville Lakes (FPR)	50	46	48	35	512,200 cfsd
Little Tennessee Projects: Nantahala, Thorpe, Fontana, and Chilhowee Lakes (FPR)	55	52	60	35	745,200 cfsd
WESTERN GREAT LAKES REGION					
WISCONSIN					
Chippewa and Flambeau (PR)	87	73	77	60	15,900 mcf
Wisconsin River (21 reservoirs) (PR)	47	38	71	51	17,400 mcf
MINNESOTA					
Mississippi River headwater system (FMR)	37	33	22	23	1,640,000 ac-ft

Reservoir Principal uses: F–Flood control I–Irrigation M–Municipal P–Power R–Recreation W–Industrial	End of Nov. 1973	End of Dec. 1973	End of Dec. 1972	Average for end of Dec.	Normal maximum
	Percent of normal maximum				
MIDCONTINENT REGION					
NORTH DAKOTA					
Lake Sakakawea (Garrison) (FIPR)	92	89	92	.....	22,640,000 ac-ft
NEBRASKA					
Lake McConaughy (IP)	84	82	80	69	1,948,000 ac-ft
OKLAHOMA					
Keystone (FPR)	117	125	95	93	661,000 ac-ft
Lake O' The Cherokees (FPR)	120	112	94	77	1,492,000 ac-ft
Tenkiller Ferry (FPR)	157	114	103	87	628,200 ac-ft
Lake Altus (FIMR)	47	47	9	47	134,500 ac-ft
Eufaula (FPR)	147	110	97	78	2,378,000 ac-ft
OKLAHOMA--TEXAS					
Lake Texoma (FMPRW)	117	103	96	89	2,722,000 ac-ft
TEXAS					
Possum Kingdom (IMPRW)	89	84	91	78	724,500 ac-ft
Buchanan (IMPW)	82	82	77	76	955,200 ac-ft
Bridgeport (IMW)	53	52	54	41	386,400 ac-ft
Eagle Mountain (IMW)	100	98	90	84	190,300 ac-ft
Medina Lake (I)	100	100	95	47	254,000 ac-ft
Lake Travis (FIMPRW)	100	100	93	74	1,144,000 ac-ft
Lake Kemp (IMW)	60	59	42	75	319,600 ac-ft
THE WEST					
ALBERTA					
Spray (P)	75	67	68	56	210,000 ac-ft
Lake Minnewanka (P)	84	79	80	64	199,700 ac-ft
St. Mary (I)	48	58	70	61	320,800 ac-ft
WASHINGTON					
Franklin D. Roosevelt Lake (IP)	95	65	98	89	5,232,000 ac-ft
Lake Chelan (PR)	62	50	51	55	676,100 ac-ft
IDAHO--WYOMING					
Upper Snake River (7 reservoirs) (IMP)	58	66	73	63	4,282,000 ac-ft
WYOMING					
Pathfinder, Seminoe, Alcova, Kortes, Glendo, and Guernsey Reservoirs (I)	71	72	63	39	3,056,200 ac-ft
Buffalo Bill (IP)	53	51	75	68	421,300 ac-ft
Boysen (FIP)	94	92	73	73	802,000 ac-ft
Keyhole (F)	79	78	83	34	199,900 ac-ft
COLORADO					
John Martin (FIR)	1	4	2	16	364,400 ac-ft
Colorado–Big Thompson project (I)	82	84	72	54	722,600 ac-ft
Taylor Park (IR)	59	59	35	53	106,000 ac-ft
COLORADO RIVER STORAGE PROJECT					
Lake Powell; Flaming Gorge, Navajo, and Blue Mesa Reservoirs (IFPR)	71	72	55	.....	31,276,500 ac-ft
UTAH--IDAHO					
Bear Lake (IPR)	79	79	80	54	1,421,000 ac-ft
CALIFORNIA					
Hetch Hetchy (MP)	63	56	34	35	360,400 ac-ft
Lake Almanor (P)	90	92	67	43	1,036,000 ac-ft
Shasta Lake (FIPR)	83	77	76	67	4,377,000 ac-ft
Millerton Lake (FI)	43	65	62	52	503,200 ac-ft
Pine Flat (FI)	50	53	32	43	1,014,000 ac-ft
Isabella (FIR)	37	37	10	22	551,800 ac-ft
Folsom (FIP)	62	62	64	50	1,000,000 ac-ft
Lake Berryessa (FIMW)	93	97	74	77	1,600,000 ac-ft
Clair Engle Lake (Lewiston) (P)	91	95	78	80	2,438,000 ac-ft
CALIFORNIA--NEVADA					
Lake Tahoe (IPR)	68	76	62	48	744,600 ac-ft
NEVADA					
Rye Patch (I)	65	69	79	.....	157,200 ac-ft
ARIZONA--NEVADA					
Lake Mead and Lake Mohave (FIMP)	77	76	72	66	27,970,000 ac-ft
ARIZONA					
San Carlos (IP)	58	56	38	12	1,093,000 ac-ft
Salt and Verde River system (IMPR)	74	72	73	35	2,073,000 ac-ft
NEW MEXICO					
Conchas (FIR)	72	72	61	77	352,600 ac-ft
Elephant Butte and Caballo (FIPR)	28	32	14	27	2,539,000 ac-ft

[a] Thousands of kilowatt-hours

METRIC EQUIVALENTS OF UNITS USED IN THE WATER RESOURCES REVIEW

(Round-number conversions, to nearest four significant figures)

1 foot = 0.3048 meter 1 mile = 1.609 kilometers
1 acre = 0.4047 hectare = 4,047 square meters
1 square mile = 259 hectares = 2.59 square kilometers
1 acre-foot (ac-ft) = 1,233 cubic meters
1 million cubic feet (mcf) = 28,320 cubic meters

1 cubic foot per second (cfs) = 0.02832 cubic meters per second = 1.699 cubic meters per minute
1 second-foot-day (cfsd) = 2,447 cubic meters per day
1 million gallons (mg) = 3,785 cubic meters = 3.785×10^6 liters
1 million gallons per day (mgd) = 694.4 gallons per minute (gpm) = 2.629 cubic meters per minute = 3,785 cubic meters per day

Provisional data; subject to revision

FLOW OF LARGE RIVERS DURING DECEMBER 1973

Station number	Stream and place of determination	Drainage area (square miles)	Mean annual discharge through September 1970 (cfs)	December 1973					
				Monthly discharge (cfs)	Percent of median monthly discharge[1]	Change in discharge from previous month (percent)	Discharge near end of month		
							(cfs)	(mgd)	Date
1–0140	St. John River below Fish River at Fort Kent, Maine.	5,690	9,397	11,580	262	+311	19,000	12,300	31
1–3185	Hudson River at Hadley, N.Y	1,664	2,791	5,080	226	+190	.....	.....	.....
1–3575	Mohawk River at Cohoes, N.Y	3,456	5,450	13,600	242	+292	.....	.....	.....
1–4635	Delaware River at Trenton, N.J	6,780	11,360	29,250	272	+406	34,800	22,500	31
1–5705	Susquehanna River at Harrisburg, Pa.	24,100	33,670	73,650	245	+192	72,000	46,500	31
1–6465	Potomac River near Washington, D.C.	11,560	[2]10,640	24,000	297	+214	41,500	26,800	31
2–1055	Cape Fear River at William O. Huske Lock near Tarheel, N.C.	4,810	4,847	3,660	100	+330	3,270	2,100	31
2–1310	Pee Dee River at Peedee, S.C	8,830	9,098	7,990	116	+73	11,200	7,200	28
2–2260	Altamaha River at Doctortown, Ga.	13,600	13,380	6,477	90	+65	7,600	4,900	27
2–3205	Suwannee River at Branford, Fla	7,740	6,775	2,910	85	–10	3,010	1,900	22
2–3580	Apalachicola River at Chattahoochee, Fla.	17,200	21,690	15,100	93	+22	18,500	12,000	27
2–4670	Tombigbee River at Demopolis lock and dam near Coatopa, Ala.	15,400	21,700	41,480	279	+388	100,000	64,600	28
2–4895	Pearl River near Bogalusa, La	6,630	8,533	21,200	531	+294	65,900	42,600	31
3–0495	Allegheny River at Natrona, Pa	11,410	[2]18,700	27,230	141	+49	59,300	38,300	28
3–0850	Monongahela River at Braddock, Pa.	7,337	[2]11,950	25,450	177	+73	70,000	45,200	28
3–1930	Kanawha River at Kanawha Falls, W.Va.	8,367	12,370	23,250	196	+116	25,000	16,200	31
3–2345	Scioto River at Higby, Ohio	5,131	4,337	7,060	434	+11	17,600	11,400	27
3–2945	Ohio River at Louisville, Ky[3]	91,170	110,600	179,100	202	+55	180,300	117,000	26
3–3775	Wabash River at Mount Carmel, Ill.	28,600	26,310	38,260	255	+178	88,900	57,500	31
3–4690	French Broad River below Douglas Dam, Tenn.	4,543	[2]6,528	17,909	156	+70	.....	.....	.....
4–0845	Fox River at Rapide Croche Dam, near Wrightstown, Wis.[3]	6,150	4,142	4,427	134	+18	.....	.....	.....
4–2643.31	St. Lawrence River at Cornwall, Ontario–near Massena, N.Y.[4]	299,000	239,100	266,000	116	–9	230,000	149,000	31
5–0825	Red River of the North at Grand Forks N. Dak.	30,100	2,439	1,813	212	–16	1,550	1,000	31
5–3300	Minnesota River near Jordan, Minn	16,200	3,306	2,120	325	–8	1,330	860	28
5–3310	Mississippi River at St. Paul, Minn	36,800	[2]10,230	9,820	202	–25	9,310	6,000	27
5–3655	Chippewa River at Chippewa Falls, Wis.	5,600	5,062	3,878	138	–6	.....	.....	.....
5–4070	Wisconsin River at Muscoda, Wis	10,300	8,457	6,542	115	–4	.....	.....	.....
5–4465	Rock River near Joslin, Ill	9,520	5,288	8,772	288	+6	8,700	5,600	31
5–4745	Mississippi River at Keokuk, Iowa	119,000	61,210	66,400	193	+6	67,900	43,900	31
5–4905	Des Moines River at Keosauqua, Iowa.	14,038	5,220	11,400	900	–2	15,000	9,700	31
6–2145	Yellowstone River at Billings, Mont.	11,795	6,754	3,279	110	–22	2,680	1,700	29
6–9345	Missouri River at Hermann, Mo	528,200	78,480	125,000	417	–2	115,000	74,500	26
7–2890	Mississippi River near Vicksburg, Miss.[5]	1,144,500	552,700	1,058,000	290	+112	770,000	498,000	31
9–3150	Green River at Green River, Utah	40,600	6,369	2,755	134	+5	4,360	2,800	31
9–4025	Colorado River near Grand Canyon, Ariz.	137,800	.....	5,740	.....	–22	.....	.....	.....
11–4255	Sacramento River at Verona, Calif	21,257	18,370	56,290	276	+32	57,500	37,200	31
13–2690	Snake River at Weiser, Idaho	69,200	17,670	18,200	122	+12	17,900	11,600	27
13–3170	Salmon River at White Bird, Idaho	13,550	11,060	5,965	137	–24	5,760	3,700	27
13–3425	Clearwater River at Spalding, Idaho	9,570	15,320	12,200	184	+83	16,200	10,500	27
14–1057	Columbia River at The Dalles, Oreg.[6]	237,000	194,000	160,000	142	+34	.....	.....	.....
14–1910	Willamette River at Salem, Oreg	7,280	23,370	81,520	188	+19	91,680	59,300	27–31
15–5155	Tanana River at Nenana, Alaska	27,500	24,040	6,148	99	–11	6,000	3,900	31
8MF005	Fraser River at Hope, British Columbia.	78,300	95,300	40,200	93	–31	35,000	22,600	31

[1] Reference period 1931–60 or 1941–70.
[2] Adjusted.
[3] Records furnished by Corps of Engineers.
[4] Records furnished by Buffalo district, Corps of Engineers, through International St. Lawrence River Board of Control. Discharges shown are considered to be the same as discharge at Ogdensburg, N.Y. when adjusted for storage in Lake St. Lawrence.
[5] Records of daily discharge computed jointly by Corps of Engineers and Geological Survey.
[6] Discharge determined from information furnished by Bureau of Reclamation, Corps of Engineers, and Geological Survey.

ALASKA

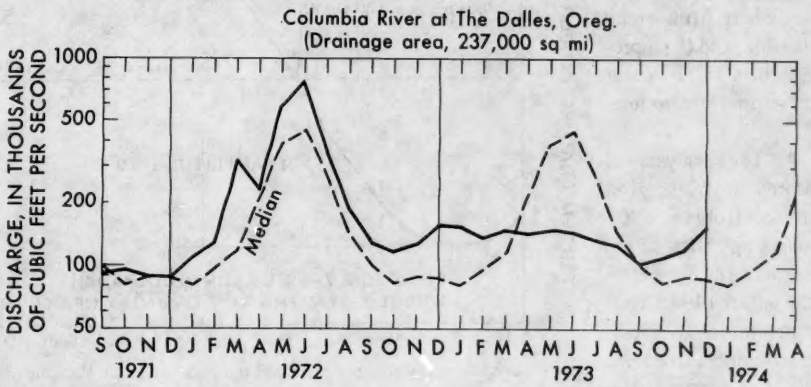
Streamflow decreased seasonally and remained below median at all index stations in the State. Monthly mean flow of Kenai River at Cooper Landing, in south-central Alaska, has been below the normal range in 6 of the past 7 months, and less than the monthly median for 8 consecutive months. In the southeast, flow of Gold Creek near Juneau was below the normal range for the 2d consecutive month and only 48 percent of the December median.

Ground-water levels in the Anchorage area continued to decline seasonally in the deep (artesian) aquifers. Levels declined also in water-table wells near the foothills but did not change near Cook Inlet.

HAWAII

Streamflow decreased in all parts of the State but remained above the normal range on Kauai island for the 2d consecutive month. Seven inches of rain fell on the western part of Kauai December 1–2, causing an estimated 50 thousand dollars in flood damage. Flow at the index station, Honopou Stream near Huelo, in northeastern Maui, decreased contraseasonally, from 4.74 cfs (129 percent of median) in November, to 2.68 cfs (59 percent of median) in December. Flows at the index stations on Oahu and Hawaii islands were in the normal range.

HYDROGRAPH OF A LARGE RIVER


Columbia River at The Dalles, Oreg.
(Drainage area, 237,000 sq mi)
DISCHARGE, IN THOUSANDS OF CUBIC FEET PER SECOND
1000
500
200
100
50
Median
S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A
1971
1972
1973
1974

Cover map shows generalized pattern of streamflow for December based on 22 index stream-gaging stations in Canada and 130 index stations in the United States. Alaska and Hawaii inset maps show streamflow only at the index gaging stations which are located near the points shown by the arrows.

Streamflow for December 1973 is compared with flow for December in the 30-year reference period 1931–60 or 1941–70. Streamflow is considered to be *below the normal range* if it is within the range of the low flows that have occurred 25 percent of the time (below the lower quartile) during the reference period. Flow for December is considered to be *above the normal range* if it is within the range of the high flows that have occurred 25 percent of the time (above the upper quartile).

Flow higher than the lower quartile but lower than the upper quartile is described as being within the *normal range.* In the Water Resources Review the median is obtained by ranking the 30 flows of the reference period in their order of magnitude; the highest flow is number 1, the lowest flow is number 30, and the average of the 15th and 16th highest flows is the median.

The normal is an average (but not an arithmetic average) or middle value; half of the time you would expect the December flows to be below the median and half of the time to be above the median. Shorter reference periods are used for the Alaska index stations because of the limited records available.

Statements about *ground-water levels* refer to conditions near the end of December. Water level in each key observation well is compared with average level for the end of December determined from the entire past record for that well or from a 20-year reference period, 1951–70. *Changes in ground-water levels,* unless described otherwise, are from the end of November to the end of December.

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This issue was prepared by J.C. Kammerer, H.D. Brice, T.H. Woodard and L.C. Fleshmon from reports of the field offices, January 11, 1974.

GENERALIZATION OF STREAM-TEMPERATURE DATA IN WASHINGTON

The accompanying abstract, graph, and table are from the report, *Generalization of stream-temperature data in Washington*, by M. R. Collings: U.S. Geological Survey Water-Supply Paper 2029-B, 45 pages, 1973; prepared in cooperation with the State of Washington Department of Ecology. The report may be purchased for $0.30 from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402 (GPO Stock Number 2401-00302).

ABSTRACT

The effect of water temperature on the ecosystem of streams necessitates an analysis of various physical characteristics that influence stream temperatures. This study was conducted to determine (1) the effective relations that define site-to-site variation in stream temperatures, (2) equations and methods to estimate stream temperatures at sites where little or no data are now available, and (3) a procedure to evaluate the effect of water impoundment on natural stream temperatures.

[From page 4: The analyses of stream temperatures in Washington were made from data from . . . 307 temperature collecting sites . . . . For a determination of the characteristics of the cyclic nature of Washington stream temperatures, to index the temperature differences from site to site, the basic data for each site were fitted to a harmonic curve . . . (See fig. 1.)]

Statistical multiple-regression analyses were used to develop equations for relations between stream temperatures and topographic and climatic characteristics of the drainage basins.

Multiple-regression techniques, generally, produced more accurate equations for estimating temperatures of streams in western Washington than for those in eastern Washington. A standard error of estimate was used to show how precisely stream temperatures may be defined by air-temperature and topographic drainage-basin characteristics. Of 24 original parameters tested, 15 were found effective to determine the equations of one or more of the 15 stream-temperature characteristics (table 1).

Effects of holding reservoirs on downstream water temperatures may be evaluated by the use of harmonic curves of probable maximum and minimum stream temperatures. By examples, it was shown that (1) below a hydroelectric-power dam, winter-minimum river temperatures were raised and occur 9 days later than they would under natural conditions; and (2) below a flood-control dam, which also augments natural flows during low-flow periods, summer-minimum river temperatures were raised and occur 4 days earlier than they would under natural conditions.

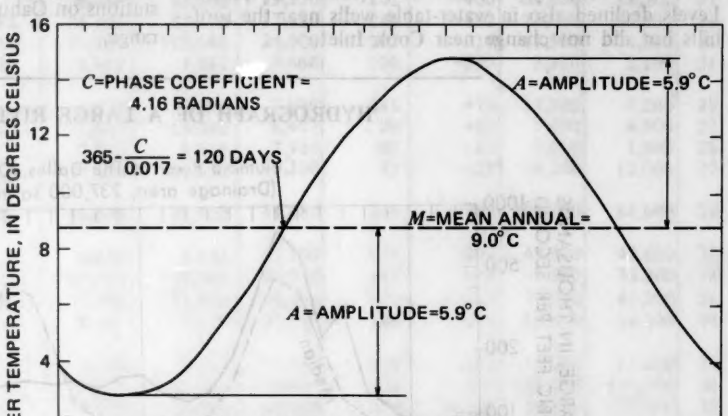

Figure 1.—Typical harmonic-fitted temperature graph showing mean stream-temperature curve, for station 12–0830, Mineral Creek near Mineral.

Table 1.—*Effective parameters in determining stream-temperature characteristics*

Topographic or climatic characteristic	Number of equations[1] where variable was found significant 95 percent of the time
Drainage area	7
Channel slope	5
Mean basin altitude	6
Mean annual streamflow	5
Altitude of data site	2
Stream length	3
Source altitude of stream	3
Area of lakes and ponds	3
Direction (orientation) of streamflow	2
Mean air temperature:	
Amplitude	1
Annual	1
January	1
February	1
August	1
October	1

[1] Usually more than one variable is found in an equation.

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